

Chapter 1

Introduction: Competing Scientific Cultures and the Globalization of Knowledge in the Iberian Colonial World

Helge Wendt

Colonial and Transcolonial Transfer of Knowledge

The globalization of knowledge in the Iberian colonies is a subject that in the last forty years has been approached from many different perspectives. Nevertheless, it is still important to investigate this knowledge formation process by attempting to evaluate the contribution of the Spanish and the Portuguese to the European scientific tradition (Bleichmar et al. 2009) and to trace the different ways this knowledge was gained. Such studies will help us reconsider our understanding of European and non-European economies of science; they will help in understanding how these scientific cultures merged and what role they played in the colonial situation at the intersection of non-human processes and human action.

Previous studies have focused repeatedly on Portuguese or Spanish colonial spaces as if these were well-defined entities, dependent on their so-called mother countries. Whether the Spanish viceroyalties of New Spain or Peru, or the Portuguese *capitanias* in Brazil, or the Portuguese State of India (*Estado da Índia*), administratively and militarily these spaces were considered territories submitted to the Crowns in Madrid and Lisbon. The *Estado da Índia*, for instance, is considered a role model for its administrative innovativeness and organization, and anticipated many of the absolutist reforms of royal powers in eighteenth-century Europe (Newitt 2005, 70). Nevertheless, the territory of the *Estado da Índia* changed continuously: it made several attempts at territorial expansion and its frontiers were constantly shifting. The internal cultural heterogeneity, including religion, was intended to be overcome by means of a Catholic mission. In this sense, mission enterprises helped establish social hierarchies, for example, by claiming the superiority of European priests over “native” clerics (Ballhatchet 1998; Boxer 1978; Wendt 2011a; Županov 2005). From this colonial perspective, empires and their colonies were considered to be rather homogeneously organized into quasi-nations, with only limited communication taking place across their borders.

Some of the research literature explores the multinational, multiethnic and multilingual character of the Spanish and Portuguese Empires. Living alongside the conquered in the colonial territories were also others who came from other regions belonging to foreign powers. Paulo Jorge de Sousa Pinto, for instance, describes the Chinese populations in different Portuguese, Spanish and Dutch colonial towns (Pinto 2013, 91–108). The multiethnic environments in towns of the Portuguese overseas dominions are studied in a volume edited by Liam Matthew Brockey (2008), *Portuguese Colonial Cities in the Early Modern World*. According to João Fragoso:

This statement provides such mercantile circuits both a specific and a structural dimension because it guaranteed the survival and dynamics of this ultramarine empire, which was fashioned by social and economic diversity. (Fragoso and Silva Gouvêa 2014, 26)

Regarding the contributions to the Spanish Empire made by the many nations residing in different “Spanish” countries, Henry Kamen, for instance, made a step towards opening the Spanish colonial space: Castilians, Catalans, Italians from northern and southern regions, Flemish, Germans, all of the Indigenous¹ groups from the Americas and the Asian territories, the Chinese, as well as the different African groups all suffered the deracination of slavery and came together in this imperial space (Kamen 2002). John H. Elliott chose an extensive comparative approach between the British and the Spanish Empires, making fragmentation processes and transcolonial communication visible:

The comparison, therefore, it’s not between two self-contained cultural worlds, but between cultural worlds that were well aware of each other’s presence, and were not above borrowing each other’s ideas when this suited their needs. (Elliott 2007, xvii)

The relation between colonial empires and some colonized regions is one factor that enriches how we consider colonial structures. Another is thinking about a colonial territory as being comprised of many different regions, with several centers of knowledge production and diffusion, all of them specialized in one or several fields of knowledge and forms of knowledge organization. Instead of a uniform colonial organization, the structure of the Iberian empires is to be considered rather *multicentric* (Gruzinski 2004), where several colonial metropolises under Spanish or Portuguese domination worked as hubs of political and economic processes and were the central points of knowledge exchange and formation. The role of Goa, Mexico, Lima, Havana, the Canaries, Manila or Ceuta

¹I have chosen to capitalize the term *Indigenous* to underline the equality with other ethnical or national designations.

(among many others) in a network of knowledge transfer within the limits of the Iberian dominations, is therefore one aspect dealt with by the contributions of this volume.

A second aspect of this publication is the transfer of knowledge between different colonial spaces: knowledge could diffuse or be transferred from Goa to Manila, from Paris to Mexico, from London to Havana, from Bahia to Seville, depicting wide spreading and loosely interconnected networks of knowledge transfer. Iberian colonialisms² are often characterized by multi-local organizations with limited capacities to create stable border regimes. Movements of knowledge could be seen to be transcolonial because they took place in a global colonial context and transgressed the limits established by colonial regimes.³

The knowledge that circulated between the continents very often comprised subjects that in this period were part of the tradition of natural history. A third perspective, which will be developed in the final chapter of this volume, will thus focus on the issue of how European sciences, working on materials communicated from the colonies, began to classify non-European nature. In this long-lasting process, many actors pursued the goal of rendering this nature exploitable to European commercial and industrial means and thus contributed to increase the human imprint in ecosystems and geology. This process of the last 200 years is described by the term “Anthropocene.” This volume intends to use this term in a transformed modus, in order to make processes of knowledge circulation and production of the sixteenth to the early nineteenth centuries more understandable.

The Structure of the Volume

The present volume considers the processes of knowledge exchange and knowledge formation that first occurred inside one of the Iberian colonial empires. With one exception, the contributions are concerned with knowledge in the non-European parts of the Spanish and Portuguese Empires. The term “colonial” in the title is therefore more than simply a territorial and political designation. Colonial also indicates a state of mind (Gruzinski 2002), practices of trade, production of goods, functioning of institutions, diffusion of religions and, last but not least, the production and dissemination of knowledge (Cañizares-Esguerra 2005). We consider the “colonial situation” (Balandier 1963) to have given a special context for the production, diffusion and use of knowledge. The term “Iberian,” as used

²It is obviously important to use the plural here because we consider Portuguese and Spanish colonial dominions to differ in their organization and in the contexts of spaces and periods.

³Cf. Wendt (2011b). One example of transgression is the role of Portuguese so-called New Christians trading between the Spanish territories of Peru and the Philippines, as was emphasized by Sanjay Subrahmanyam (2012, 127).

in the title, will be used repeatedly in this introduction, whereby “Iberian” is used as a mere geographical designation for the Iberian Peninsula with its heterogeneous political and linguistic as well as religious and cultural structure. For the period from the sixteenth to the nineteenth centuries, the two monarchies (that are considered to be historically linked to the currently existing states) had stabilized their domination over earlier and competing reigns of the Iberian Peninsula. Incidentally, the Portuguese and the Spanish Crowns became briefly unified from 1580 to 1640, but even during this short period, their colonial policies differed greatly.⁴ The use of the term Iberia is by no means an attempt to unify the two Crowns or the territories they dominated in the non-European world. Rather, its use should reflect their differences, as would be the case for any other commonly used term.

The processes of knowledge exchange and knowledge formation dealt with in this volume involve the communications between the so-called metropolis and the colonies, as well as within the colonies themselves between the various groups of the colonies’ population. Communication of knowledge inside these colonial spaces were complicated by the great distances that separated the communication partners. Furthermore, communication, dissemination and diffusion of knowledge were never limited by colonial borders but stood in a transcolonial network of knowledge exchange. Therefore, the formation and generation of knowledge in the Iberian colonial world is intrinsically tied to similar processes in other parts of the world, leading to the epistemological situation of global entanglement whereby we now deal with the consequences of actions taken centuries ago or in distant regions of the world.

This volume focuses on botanical and medicinal knowledge transfer and transmission processes. It also provides insights into a history of knowledge related to mining and reflects on the linguistic dimensions of processes of knowledge transfer. There is also a critical historiographic dimension in the contributions that provides new readings of well-known sources and a direct debate of the research literature. Regretfully, the volume does not include as many examples from the Portuguese colonial world, as it does from the Spanish. This shortfall is due to the unpredictability of the editorial process. Again, I would like to emphasize that important studies on knowledge and its transfer in the Portuguese Empire have been published elsewhere (Bleichmar et al. 2009).

In his contribution, José Pardo-Tomás combines different forms of how natural knowledge was transmitted in New Spain during the sixteenth century. He concentrates on written and pictorial testimonies dealing with issues that can be subsumed under natural history. Whether in paintings of the Augustinian convent of Malinalco, in the writings of the physician Francisco Hernández that were sent

⁴Cf. Subrahmanyam (2012), esp. the chapter “Between Land-bound and Sea-borne.”

to New Spain by the Spanish king or in writings representing a more local perspective on “nature,” such as those by Muñoz Camargo, Pardo-Tomás offers an insight into a corpus of knowledge that historiography used to split into almost unrelated fields of research.

The sphere of the Catholic religion and its institutions, such as missions, was an important space, where different kinds of knowledge could be communicated. Lars Kirkhusmo Pharo focuses on moral knowledge that missionaries disseminated when dealing with very European concepts, such as sin or penitence. He studies the difficulties of translating such concepts from Latin or Spanish into Nahuatl, Mixtec and Quechua. This contribution helps us understand how cautiously translingual transfers of knowledge should be investigated. Furthermore, it points to the intention of European actors, such as the missionaries, to incorporate and alter Indigenous linguistic systems in order to impose their own interpretations.

In her contribution, Sonja Brentjes focuses on the work by Garcia da Orta on Indian medicinal plants. She offers an alternative reading to a source that is often considered an example of cross-cultural transfer of knowledge. She combines a biographical approach to Orta with a critical analysis of the political situation in mid-sixteenth century Goa. Brentjes argues that the printed work of the *Coloquios* should be understood as a product of the highly diversified colonial situation in Goa, and thus reconsidered in this very context.

Emma Sallent deals with a transfer of knowledge between Europeans and Indians in her contribution on Francisco de Motolinia’s *Historia de los Indios*. Her main focus lays on the Franciscans, especially on Motolinia. Sallent argues that terms of natural history were part of a vast conversion movement. In her contribution, Sallent makes it obvious that social spheres, like the religious and the scientific spheres, should be considered as being entangled rather than separated from each other.

Timothy D. Walker gives a rich overview of the many treatises published in the Portuguese Empire dealing with medicinal plants. He argues that these publications helped disseminate Indigenous medical knowledge and practices from one part of the Portuguese dominions to other regions and even beyond the frontiers of the Lusophone world. Walker provides the reader with a comprehensive list of oeuvres published from the sixteenth to the eighteenth centuries, which also reveals the infrastructures and institutions that helped organize the transfer of knowledge.

The communication between often separated spheres of knowledge is also a subject in Angélica Morales Sarabia’s contribution. She provides us with an account that integrates contributions from Indigenous and Spanish actors to the development of knowledge in the field of medicine. From a gender studies per-

spective, Morales Sarabia asks which conditions were needed for certain types of knowledge to pass from a female to a male, as well as from an Indigenous to a Spanish sphere of knowledge. Although, she faces the problem of sources being silent about informants, Morales Sarabia depicts the process of how knowledge became stabilized and hierarchized in New Spain, starting in the sixteenth century and ending in the nineteenth.

Mauricio Sánchez Menchero studies the transfer of knowledge via books about tobacco from Spain to England in the sixteenth century. He presents the different local and transcolonial contexts between Seville, London, Paris and Anvers, in which knowledge about this plant and its uses evolved. Furthermore Sánchez Menchero shows how social and political questions were important for the way this knowledge was achieved and disseminated.

Nuria Valverde Pérez stresses her conviction that mining maps of New Spain make an important contribution to knowledge of the social, geological and juridical contexts. Thus, mining maps express strategies for risk management. They can be considered, nevertheless, as testimonies of communication between theoretical and practical knowledge, between different social spheres and between different approaches to the “right” way to depict mines and geological data.

The contribution from Helge Wendt shows how different actors in the late Spanish colonial empire organized the transcolonial transfer of knowledge. Actors in the different administrations, mining engineers and entrepreneurs all had different reasons for accumulating useful knowledge about coal mining, which was an emerging economic branch in Cuba. Between 1828 and 1854, coal mining in Cuba can serve as an example of the interplay of knowledge formation, economic expectations and social transformation.

The final contribution by Helge Wendt on the Iberian path to the Anthropocene attempts to draw similarities with what in recent years have been called alternative ways to modernity in colonial and global histories (Eisenstadt 2002; Randeira 1999). Furthermore, different forms of industrialization have been studied under the terms of proto-industrialization (Kriedte, Medick, and Schlumbohm 1981; Schlumbohm 1996; Ogilvie and Cerman 1996) and industrial revolution (Bayly 2004; Vries 1994; 2008). The chapter therefore intends to underline the fact that the colonial era, even before the accelerated industrial evolution in Europe, was an important factor in forging the epistemological basis of what would happen in Europe during the nineteenth and twentieth centuries. Just as there were many paths leading toward industrialization, there is certainly more than one path to the Anthropocene.

Topologies of Systematization

Local Conditions for Knowledge Production and Dissemination

Some conditions in the Iberian colonial world created a situation where natural history and natural philosophy became the main frameworks wherein knowledge was produced and disseminated (Pardo-Tomás 2002; Simões et.al. 1999). They are considered in the writings of imperial history as being in the service of the ideology of imperial centralization. Furthermore, natural history and philosophy were forms of knowledge formation that preceded the early nineteenth century's human geography and geology. Nevertheless, the relations between local knowledge and highly transformed translocal knowledge systems, often part of the metaphysical system of Spanish Roman Catholicism, were never organized in a purely bottom-up or upside-down manner. Parts and packages of knowledge moved steadily vertically between the different levels of knowledge, being integrated into different spaces of knowledge production and contexts of the practical and theoretical implementation of knowledge. So-called local knowledge was rapidly transferred into other local spaces and alocalized knowledge—at least in its rhetorical dimensions—used to be transferred to different local contexts.

Contemporaries, such as William Temple (1628–1699), already observed such transfers between systems of knowledge. He wrote in his essay *On Ancient and Modern Learning* (1690), as the soil and the climate influence a tree's growth, so knowledge depends on local conditions to arise and evolve.

May not the same have happened in the production, growth, and size of wit and genius in the world, or in some parts or ages of it, and from many more circumstances that contributed towards it, than what may concur to the stupendous growth of a tree or animal? May there not have been, in Greece or Italy of old, such prodigies of invention and learning in philosophy, mathematics, physic, oratory, poetry, that none has ever since approached them, as there were in painting, statuary, architecture? (Temple 1814, 463)

The rather organic image used by Temple, although it concentrates on the bottom-up movement, refers also to a kind of intersystemic transfer of knowledge, when he mentions the climate influencing the growth of the tree of knowledge. Temple's image might therefore be useful in exploring further evolution processes of systems of knowledge at the intersection of the local, the systematic and the intersystematic.

The impact of locality becomes visible when the circulation of knowledge is researched in relation to central institutions and decentralized contexts, between

different forms of systematized knowledge and between more local and more global forms of knowledge. There is no doubt that science came about in the form of the systematization of general knowledge. However, it was not clear in the beginning which type of systematization would become recognized as being scientific and which other and alternative forms of systematized knowledge would not. Thus, the process of “scientification” is a process of interlocal communication in the forms of cooperation and competition. Institutions worldwide communicated on the advantages or disadvantages of one or the other type of systematization. What in hindsight became labelled as “science” was born out of these interactive processes which aimed at the best description and penetration of natural phenomena.

We know today that the “local” is not a place that, in more or less remote times, was isolated from its geographic surroundings. We call local knowledge the knowledge that in a given social and geographical space and for a given time span emerges in consequence of previous and concurrent communication of knowledge with other “localities.” This is due to its problem solving capacity for the local community, or parts thereof (Renn 2012, 369). Local knowledge is therefore entangled with other local conditions and knowledge production. This interlocal entanglement of knowledge confronts different traditions of organizing and depicting knowledge. Furthermore, the knowledge that is useful in one community in a given situation can differ from that in another community.

The evolution of science is tied to political and economic factors as well as issues of practicality, and is characterized by intercultural and interlocal communications. Each of the complex systems defends its particular perspective of only one valid form of classification. Competing forms of systematization, which existed simultaneously in the Iberian and the outer-Iberian worlds, show the variety of ways to systematize the scientific knowledge that evolved during the interaction between different traditions and new evolving forms of scientific approaches and that were supported by different institutions.

In this way, histories of the evolution of scientific knowledge and the transfer of knowledge in the Iberian world may differ from those that, for example, evolved in the English, Dutch or German scientific worlds (Elena and Ordóñez 2000). At the same time, the “Iberian” systems of knowledge were in constant exchange and competition with non-Iberian systems of knowledge, as Mauricio Sánchez Menchero underlines in his contribution to this volume. The differences between scientific and social cultures are important to the historical actors in order to create spaces of identity and to the historians to create frameworks of narration. As a result, both the interactions within the colonial-imperial system of power and foreign systems of power, such as between the Spanish and the British, for instance, must be intensively analyzed. These interactions of colonial-imperial

nature can be completed by “autochthonous” interrelations, that is, between different Indigenous groups and of course, should also take into account those only partly related to systems of political organization.

The transfer of knowledge, information exchange and systematization that occur in these processes all functioned in different ways. One way was through espionage, where the ruler would want to obtain knowledge from other areas. Another way was through the communication and scientific interests of various individuals. The exchange of knowledge in fields of religion was also a common conduit for interlocal and global dissemination. Others channels involved contract research on “foreigners” (such as the voyage of Humboldt, for instance) and the exchange of scientific information within networks existing within colonial borders and between colonial territories.

Changes in the Conception of Knowledge

The Portuguese and Spanish imperial spaces also manifest various differences in how knowledge had been and could be transferred. Agency plays its important role, making transfer processes dependent on the persons involved. Aside from the question of the quality of knowledge transferred or of the process itself, the differences occur when a European or a Creole⁵ from America was involved, and if he or she was a member of one of the Indigenous groups—a Mestizo, an African, a Mulatto or a foreigner traveling and communicating inside the imperial spaces. Angélica Morales Sarabia gives a good example of dealing with knowledge about medicinal plants by taking into account the gender of the authors who communicated, of the informants and of the partners with whom she or he was engaged in this transfer of knowledge. Morales Sarabia also highlights the importance of studying what happened to knowledge once acquired—in which form it was published or otherwise diffused.

In this sense, the present volume shows examples of how important Indigenous actors were for the development of forms of knowledge that consist in the mixing of non-European and European bodies of knowledge. These comprise political, cultural and social knowledge, as well as knowledge about natural phenomena and objects. In particular, José Pardo-Tomás illustrates in his contribution the multilayered processes in the formation of so-called natural history in the Americas, including local practices, artistic representation and “scientific enterprises.” He focuses on the interplay between single persons (Europeans and Amerindians), the Spanish Crown and the places where knowledge was generated and how it was depicted.

⁵ *Creole* denotes people of Spanish-European origin born in the Americas.



Figure 1.1: This plate shows New World plants in order to make them understandable and comparable for a European audience. Clavijero *Storia antica del Messico* (1780). Biblioteca Nacional de España, GMM/3015.

In the Americas, bodies of knowledge stemming from Europe were adapted to American contexts. When erudite Creoles or Amerindians began to work with such systematizations of knowledge, as for instance, Francisco Xavier Clavijero's (1731–1787) application of the botanical system of Carl Linnaeus (1707–1778), they quickly reached the limits of these kinds of transferred systematizations (Lafuente and Valverde 2005). Alfred W. Crosby in his famous *Columbian Exchange* (1972, 2003) stresses the fact that the Aristotelian based system of knowledge, transformed by

Hippocrates, Galen, and Avicenna [who] occupied whole shelves of every good fifteenth-century library from Baghdad to Oxford to Timbuktu, but these three giants of medicine had not a word to say about syphilis. (Crosby 2003, 9)

Clavijero tried to work with the classification systems in botany proposed by Jacques-Christophe Valmot de Bomare (1731–1807), the Plynian (23–79) descriptions of plants and American knowledge including the works of Francisco Hernández (1514–1587).

Clavijero mentions some of the plants depicted in his texts and gives further descriptions of them. The *xiloxochitl* (Fig. 1.1, number 2) is a tree-flower that Clavijero describes as coming from a large tree whose leaves are similar to those of the maple (Clavijero 1780, 64–64). Clavijero does not refer to the traditional and religious use of the flowers (see 1993), but to a more commercial use of the tree's resin. This is the reason why he described the *xiloxochitl* before describing *copal*, the best known Mexican incense. The allusions to maple and to *copal* were intended to render this plant more understandable to Europeans. In describing and classifying Mexican plants in a manner that used the forms of Francisco Hernández or Carl Linnaeus, Clavijero's work was pioneering. Nevertheless, the erudite priest Francisco Clavijero, who also wrote about the histories of pre-Spanish and post-conquista New Spain and California and had written a biography on the Franciscan missionary Junípero Serra (1713–1784), underlined the limited use of those “imported” taxonomies:

The experts in Natural History would prefer that when speaking about the Reign of Plants, the plants of California should be classified following one of the systems invented by the modern naturalists; but nor are there so many vegetables in that peninsula that their number requires such an method, nor would the notions we have of them be sufficient; nevertheless, we will apply the same system we used in the *História de México* because this is the one most adapted to the knowledge of any kind of person. (Clavijero 1990, 17)

Clavijero gave priority to his own classification system and thus showed how actors could influence formation processes of knowledge by referring to some bodies of knowledge, adapting them, introducing new bodies of knowledge and elaborating their own categories and systematizations.

Objects and the Circulation of Knowledge

The object of knowledge is a factor that shapes the conditions of how knowledge can disseminate. The physical features of an object of knowledge shape the possibilities of exchange or diffusion. Some objects, such as plants, stone samples, living or embalmed animals, books and written testimonies could be displaced when political control and transportation facilities allowed for such a dislocation. Trees, large animals, landscapes and religious or social systems could only be transferred through sketches, paintings and descriptions. Dislocation and the transfer of representations of objects of knowledge altered what could be known about that object and relocated it into new contexts of knowledge.

In consequence, some objects were more commonly adapted than others. Both the possibility for translocation and an object's characteristics that define its possible uses explain the steps people took to share knowledge and to acquire and consume the object. Different bodies of knowledge were shaped and defined by rather local and natural conditions of biology, geology, mineralogy or meteorology. Compared to the laws of physics, which claim to be universally valid, other fields of knowledge depend much more on local contexts. These objects are in many cases part of knowledge economies, which do not extend the social space where they are used, consumed and experienced. The plants, climatic conditions and minerals had been part of Amerindian knowledge systems long before the Europeans arrived and began to describe them in the aftermath of their conquests.

Europeans often felt that a simple negation of these kinds of knowledge was impossible because they considered the local conditioning from nature and knowledge to be a helpful and necessary vehicle of knowledge transmission and therefore tended to include it in European systems of knowledge. The acknowledgement that there was no *terra nullius* led to alternative classification systems such as those of Francisco Hernández and Francisco Xavier Clavijero, which altered the European as much as the "American" systems they competed with.

The Scientific Divide

Centralized, interlocal, decentralized and transcolonial transfers of knowledge all developed in relation to one another, not separate from one another. Tak-

ing this approach to the Iberian knowledge space opens up new possibilities in dealing with historiographic traditions, which have perceived this Iberian global space of knowledge formation as a special, peculiar and somewhat odd structure (Cañizares-Esguerra 2009). This space of knowledge circulation has in the past often been declared as incommensurable with systems of knowledge that have evolved in Protestant and “enlightened” knowledge systems. These Protestant and enlightened knowledge systems claim to have developed without the help of Iberian “scholastic” and “late scholastic” knowledge production, for those, according to such scholars, would not have been able to add any quality results in the first place.

Pardo-Tomás underlines in his contribution to this volume that scholastic science was formed by the interplay of different forms of knowledge. In arguing this, a common understanding is challenged that relied on a model of missions and people sent out from the colonial center to regions under colonial control in order to accumulate and gain knowledge in specific fields such as demography, botany, linguistics, mineral wealth or history. These “scientific missions” were altered by unintended side effects, as knowledge was formed “during the task” as a result of interaction between the European “scientific” and “local” cultures of knowledge. To trace this kind of interaction, careful study has to be carried out, as Sonja Brentjes underlines in her contribution. For instance, the communication between a European author and his “Indigenous” informants or communication partners has to be reconsidered again and again. Brentjes studies the case of the Portuguese physician Garcia da Orta, who resided in Goa, his social relations and the threat of being interrogated by the Inquisition. These circumstances, Brentjes argues, might also have had an important influence on his research and shaped his work as much as all the “native” knowledge he crammed into his oeuvre.

Thus, even when the circulation of knowledge followed the paths imposed and implemented by the colonial-imperial organization, the bodies of knowledge exchanged by different actors certainly differed from the results primarily envisaged by the initiator of a scientific mission. When, for instance, the visitor Bartolomé de las Casas (1484–1566) was appointed to redact the first census of New Spain in 1552, the information gathered helped him to write his far-reaching report on the disastrous impact the Spanish colonial domination had had on the Indigenous population (Abril Castelló 1987).

In many historical works dealing with the development of knowledge in colonial contexts, a further gap can be perceived in the scholarly research—in addition to the scientific divide between enlightened and non-enlightened systems of knowledge, say, between northern Europe and the Iberian south—namely, the question of how scientific and useful so-called Indigenous knowledge can be related to European knowledge. Kapil Raj (2013) has pointed out that in order to

overcome the debates about the non-scientific character of non-European knowledge, one has to ascribe a form of scientificity to systems of knowledge that are based on “production of knowledge, practices, instruments, techniques, and services” (Raj 2013, 343). To this perspective on the context related production of knowledge for resolving practical problems, a second order perspective can be added that firstly takes into account the metaphysical framework of knowledge production (Agrawal 1995, 422–423) and secondly, the self-reflexivity of systems of knowledge:

Every human society deals with the generation, transmission and application of knowledge and has accordingly also developed meta-knowledge about these processes. This meta-knowledge may not necessarily become expressed in statements about knowledge but may also be implicitly represented by certain social practices, such as communal or hierarchically organized decision processes, the social organization of learning processes, or the ways in which knowledge is encoded in religious activities. In this way, second-order epistemic frameworks are generated and maintained that regulate the power typically coming with knowledge. (Renn 2012, 376)

As with religion, there might be similar expansive social and cultural systems that are able to assimilate new bodies of knowledge and at the same time impose their own systematized knowledge to foreign systems. It might also be that in a given historical circumstance, one system of knowledge, as it travelled with political or religious expansion, overpowered another. This suggests a kind of expropriation of bodies of knowledge and, in some situations, even the dissolution of a whole “Indigenous” social organization, but with some parts of the system surviving independently or in amalgamation with the colonial system of knowledge. This is one of the issues discussed by Lars Kirkhusmo Pharo. The understanding in intersemiotic communication found in missionaries’ writings about “sin” and other moral transgressions communicates systems of knowledge related both to the religious and the civil worlds. By pertaining to such complex epistemological communication systems, so-called neo-Indigenous knowledge could be re-established and recomposed in recent Indigenous movements. Kirkhusmo Pharo aims to find out what the colonial missionaries knew about the old Indigenous systems of knowledge, which often became unacknowledged parts of the colonial knowledge economy. Kirkhusmo Pharo states that some aspects of Indigenous knowledge were even adapted to the needs of the European forms of scientific language and systematization. Others were openly exhibited as being of “exotic” origin in order to increase the distance between colonialist and colonized cultures of knowledge.

Both “divides” expressed by some studies are to be challenged by radically changing the perspective—as there is no “world science” in an abstract meaning, scientific traditions and the contribution of local and regional economies of knowledge have to be re-evaluated. The divide between Iberian economies of knowledge and the more Protestant of Dutch, British or (partly) German traditions is challenged by different works: This unity of what has been called “European science” can be questioned, as Patiniotis and Gavroglu (2012) have shown. The importance of knowledge economies of the so-called European peripheries for the evolution of sciences in Europe has been underlined by Gavroglu et al. (2008). This group intends to show “the significance of the processes of appropriation of scientific ideas, practices and techniques through the multifarious (local) cultural processes, to bring to surface the specificities of local sites which have had a decisive role in knowledge production, and to underline the decisive active role of all those whose intellectual, professional and often political interventions shaped the processes of appropriation” (Gavroglu et al. 2008, 154). These points go further than simply studying contributions of “peripheral” knowledge systems to the alleged higher forms of sciences: they indicate the autonomous status of alternative and different knowledge economies that are worth studying. Later in this volume, the issue of the presently discussed concept of the Anthropocene will be examined. It is intended to use this concept to make it understandable how past cultures and economies of knowledge could be studied as alternative paths to the present state of the Anthropocene.

The knowledge concerning the religious sphere and the daily surveillance of personal comportment resulted from the translation of complex concepts from one economy of knowledge into another. This happened under conditions when both systems of knowledge communicated in the context of colonial asymmetry of power. This situation can be compared to cases presented in the present volume such as *Making of Natural History in New Spain*, studied by José Pardo-Tomás, as well as the evolution of the medicine and its forms of description and depiction, presented by Angélica Morales Sarabia. Due to different cultural, religious and political spheres, the people who were part of different knowledge systems were conditioned to deal with nature in different ways. The fact that these people had the possibility to move between these spheres enabled bodies of knowledge, which previously had scarce contact, to communicate.

In the colonial circulation of knowledge, these forms of mixing created new bodies of knowledge, with sometimes intended, but often unintended consequences. In addition to the above-mentioned point, transfer of knowledge also happened in forms that depended less on government funded research activities. The exchange of knowledge in a “rectangle” between European and

Indigenous systems of knowledge, as well as between different Indigenous actors and between European actors, led to a hybrid form of knowledge.

Imperial Infrastructure and the Circulation of Knowledge

The Iberian economies of knowledge—including the colonial ones—developed in multiple contexts of traditions and impulses from the outside. They were shaped by the infrastructures and geographical spaces in which they were rooted. The exchange of knowledge in the sixteenth century therefore differed from exchange in the nineteenth century: both the technical infrastructure of communication and the centers of knowledge both inside and outside of the Iberian empires had changed. The issues that were brought to light depended on the context of time and place. In the sixteenth century, the systematization of knowledge was often based on the religious and theological worldview imposed by the Catholic Church. In the nineteenth century, after a century of Spanish and Portuguese participation in and adaptation of knowledge from the Enlightenment, knowledge formation and the organization of knowledge in erudite circles, academies, specialized schools and universities depicted this trans-European tendency (Lafuente 2000; Sánchez Menchero 2012; Withers 2007).

On the one hand, the forms of gaining and organizing knowledge changed, as well as the issues it dealt with, yet on the other hand, the power structures remained rather stable, although their frontiers often shifted.

The internal organization of the European territories was a fairly stable and long-lasting construction, with the capitals in Madrid and Lisbon and the viceroypalties (not only) in the colonial domains, the *Capitanias* and *Audiencias*. As with governmental organization, the ecclesiastical infrastructure established in the colonies—bishoprics and parishes—were one branch of the religious institution. The other was formed by the religious orders, the Augustians, Dominicans, Franciscans and the Jesuits, to mention just a few of the orders that spread to the colonial territories and established a spatial organization of their own. The religious orders formed provinces and the different territories competed with other ecclesiastical territorial orders, such as bishoprics. All of them founded schools and colleges wherein young Creoles and sometimes Indigenous men were educated.

In the Spanish territories, several universities were founded during the sixteenth century (among others) in Santo Domingo (1538), Lima (1551), Mexico (1551), Bogotá (1580), Quito (1586) and Cebu (Philippines, 1595), which furthermore shaped the landscape of knowledge in the Iberian colonies. All of them were founded by religious orders and grew out of a conglomerate of colleges already established in the towns. Following the same pattern, throughout

the seventeenth century universities were founded in Manila (1611), Santiago (1621, Chile), Córdoba (1621, Argentina), Sucre (1621), Mérida (1624, Yucatan), Guatemala (1676) and Cuzco (1690)—to mention only a few. During the eighteenth century, new universities emerged in other capitals of viceroyalties such as Havana (1721), Popayán (1744) and Guadalajara (1791).⁶

All of the universities were meant to propagate the Catholic faith and to create an elite that was devoted to its interpretation in the colonies (Elliott 2007, 203–207). This religion-based circulation extended beyond the walls of the universities. In parishes, colleges, schools and the mission stations, the Catholic faith was propagated. But instead of this Spanish-Catholic faith being characterized as a homogenous system of beliefs, it should be understood as a system of divergent currents represented by the religious orders and multiplied by the countless “fields of praxis.” No universities were founded in the Portuguese Empire. The Jesuits, who were influential in the Portuguese universities (especially in Evora), established colleges (*colegios*) in all parts of the Portuguese Empire. Havighurst and Moreira (1969) report on a situation rather similar to the Spanish colonial context for the Portuguese colonies in Brazil: education was very much related to religion because of the Jesuit organization of schools and higher education. For the purpose of recruiting young men, the Portuguese Jesuits organized the exchange of pupils from European to colonial colleges. At the same time, in contrast to the Spanish, they denied access to the *Companhia de Jesus* to all non-Europeans (Wendt 2011b, 243–244). Later, other Catholic orders offered education and organized the formation of a so-called native clergy, which, even after colonial domination had ceased, gave the Portuguese a certain degree of influence (Wendt 2011b, 263–264).

The religious sphere of knowledge circulation was highly heterogeneous and open to adapt to local conditions as well as to adopt influences from “abroad.” This “abroad” is defined as being non-Catholic religious spheres, as the pre-Columbian religious systems were still predominant in many parts of the Spanish and Portuguese empires.⁷ The issues of knowledge circulating in this religious sphere were comprised of theological issues and included and contributed to bodies of knowledge of natural philosophy and natural history such as botany, biology, geography and geology.

Knowledge circulated between local systems of knowledge, often transmitted by priests, missionaries, public servants or merchants. In addition, trained scientists, physicians and teachers diffused knowledge and contributed to the interlocal communication of knowledge. Timothy D. Walker gives an overview

⁶For the foundation of universities in the Spanish colonial territories during the Enlightenment, cf. Soto Arango (1995).

⁷See chapter 3 of this volume by Kirkhusmo Pharo.

of Portuguese botanical manuscripts that disseminated medical knowledge from the sixteenth to the eighteenth centuries. This medical knowledge, comprised of “Indigenous” bodies of knowledge that were integrated into a European Galenic system of medicine, circulated rather freely among people that held the same interest: to increase the possibilities of healing. Knowledge was also communicated in a more hierarchical manner, although the hierarchy itself was not necessarily intended to diffuse knowledge. This communication of knowledge from the bottom to the “imperial top” could occur through direct contact, but mostly depended on mediators and translational steps. This “communication chain” happened to be more or less public; secrecy in the transmission of knowledge was part of the formation process of knowledge in the Iberian empires. Consequently, much of the knowledge gained in the Americas, Africa, India and other parts of South Asia were never published and remained under lock and key in libraries, archives and private personal collections, ecclesiastical institutions or governmental establishments. For instance, the works of the Franciscan Bernardino de Sahagún (1499–1590) and of Guaman Poma de Ayala (1550–1616) were published only in the late eighteenth and nineteenth century. The knowledge transmitted by both authors remained confidential and was circulated within a very limited group of people.

The existence of tacit, unpublished or public knowledge that is particular to the Iberian colonial context does not influence the fact that knowledge was indeed produced, even if it circulated in restricted forms. The above-mentioned colonial infrastructure of political, religious and economic organizations that was implemented improved and enforced, willingly or involuntarily, the circulation of knowledge. Between the different local institutions of the widespread organizational units, knowledge formed in one local context and, depending on local contexts of competition, could gain an interlocal and supralocal impact. This impact depended on the comparability or even reproducibility of similar conditions in other places. Another factor that facilitated knowledge transfer was the direct or mediated communication between different institutions or actors belonging to the same institutional organization. Nevertheless, communication of knowledge did not end at a colonial border, as the communication lines established in the colonial period were part of intercolonial and transcolonial circulation; despite colonial jealousies and official restrictions, commercial exchanges trespassed borders. Furthermore, political communication also reached foreign countries and “public officers” used to look for useful knowledge beyond their immediate surroundings, both in times of peace and of war.

These exchanges occurred in many social sectors comprising those that are less directly related to the sciences and education. This is the case for political organization, trade and proto-industrial production processes. The Dutch

techniques of cultivating and processing sugar, for instance, came to the Spanish West Indies because of espionage, Spanish aggression against Dutch ships and the commercial—often black market—contacts between Spanish and Dutch merchants. Under these conditions, new hubs of knowledge could arise. Some of them were only of brief importance (at least as hubs of knowledge): during this Dutch-Spanish exchange of knowledge about sugar, for instance, Curaçao was an important center of knowledge exchange that lost this role when Spanish producers of sugar became as successful in sugar production as their Dutch competitors (Galloway 1989, 48–83).

In many parts of Europe during the late seventeenth and eighteenth centuries, the intellectual, economic and political movements of the Enlightenment began to emerge. These movements influenced the Iberian countries and scientific communities, who developed conventional forms of enlightened politics, economics, science and institutions. Subsequently, the reformations of political organization, economic politics and education in Portugal and Spain during the enlightened decades of the second half of the eighteenth century show how different spheres of knowledge could evolve in the empires, while expressing a certain incommensurability with the religious, Catholic sphere. It was during the time of the transimperial merging of knowledge, when intellectuals and their writings circulated throughout the European continent and reached to the Americas and the colonized Asian territories that “enlightened” institutions of specialized schools and academies were inaugurated (Simões, Carneiro, and Diogo 1999; Camprubí 2009).

References

- Abril Castelló, Vidal (1987). Las Casas contra Vitoria, 1550–1552: La revolución de la duodécima réplica. Causas y consecuencias. *Revista de Indias* 47(179):83–101.
- Agrawal, Arun (1995). Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change* 26:413–439.
- Balandier, George (1963). *Sociologie actuelle de l’afrique noire*. Paris: Presses Universitaires de France.
- Ballhatchet, Kenneth (1998). *Caste, Class and Catholicism in India 1789–1914*. Richmond: Curzon Press.
- Bayly, Christopher A. (2004). *The Birth of the Modern World, 1780–1914: Global Connections and Comparisons*. Oxford: Blackwell.
- Bleichmar, Daniela, Kristin Huffine, Paula De Vos, and Michael Sheehan, eds. (2009). *Science in the Spanish and Portuguese Empires*. Stanford: Stanford University Press.
- Boxer, Charles R. (1978). *The Church Militant and Iberian Expansion (1440–1770)*. Baltimore/London: The Johns Hopkins University Press.
- Brockey, Liam M. (2008). *Portuguese Colonial Cities in the Early Modern World*. Farnham: Ashgate Publishing.

- Camprubí, Lino (2009). Traveling Around the Empire: Iberian Voyages, the Sphere, and the Atlantic Origins of the Scientific Revolution. *Eä: Journal of Medical Studies and Social Studies of Science and Technology* 2(2):1–24.
- Cañizares-Esguerra, Jorge (2005). Iberian Colonial Science. *Isis* 96:64–70.
- (2009). Introduction. In: *Science in the Spanish and Portuguese Empires, 1500–1800*. Ed. by Daniela Bleichmar, Paula De Vos, Kristin Huffine, and Kevin Sheehan. Stanford: Stanford University Press, 1–5.
- Clavijero, Francisco Xavier (1780). *Storia antica del Messico: cavata da' migliori storici spagnuoli ... divisa in dieci libri, e corredata di carte geografiche, e di varie figure e dissertazioni ... opera dell' Abate D. Francesco Saverio Clavigero, tomo I*. Cesena: G. Biasini.
- (1990). *Historia de la Antigua o Baja California*.
- Crosby, Alfred W. (1972). *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Westport, Connecticut: Greenwood Press.
- (2003). *The Columbian Exchange: Biological and Cultural Consequences of 1492*. 30th anniversary edition. Westport, Connecticut: Praeger.
- Eisenstadt, Shmuel N. (2002). Some Observations on Multiple Modernities. In: *Reflections on Multiple Modernities: European, Chinese and Other Interpretations*. Ed. by Dominic Sachsenmaier, Jens Riedel, and Shmuel N. Eisenstadt. Leiden: E. J. Brill, 27–41.
- Elena, Alberto and Javier Ordóñez (2000). Science, Technology, and the Spanish Colonial Experience in the Nineteenth Century. *Osiris* 15:70–82.
- Elliott, John H. (2007). *Empires of the Atlantic World. Britain and Spain in America 1492–1830*. New Haven: Yale University Press.
- Favrot Peterson, Jeanette (1993). *The Paradise Garden Murals of Malinalco: Utopia and Empire in Sixteenth-Century Mexico*. Austin: University of Texas Press.
- Fragoso, João and Maria de Fátima Silva Gouvêa (2014). Nas rotas da governação portuguesa: Rio de Janeiro e Costa da Mina, séculos XVII e XVIII. In: *Nas rotas do Império. Eixos mercantis, tráfico e relações sociais no mundo português*. Ed. by João Fragoso. Vitória: EDUFES, 25–67.
- Galloway, J. H. (1989). *The Sugar Cane Industry: An Historical Geography from its Origins to 1914*. Cambridge: Cambridge University Press.
- Gavroglu, Kostas, Manolis Patiniotis, Faidra Papanelopoulou, Ana Simões, Ana Carneiro, Maria Paula Diogo, José Ramón Bertomeu Sánchez, Antonio García Belmar, and Agustí Nieto-Galan (2008). Science and Technology in the European Periphery: Some Historiographical Reflections. *History of Science* 46(2):153–175.
- Gruzinski, Serge (2002). *The Mestizo Mind*. New York: Routledge.
- (2004). *Les quatre parties du monde. Histoire d'une mondialisation*. Paris: Édition de La Martinière.
- Havighurst, R. J. and J. R. Moreira (1969). *Society and Education in Brazil*. Pittsburgh: University of Pittsburgh Press.
- Kamen, Henry (2002). *Spain's Road to Empire: The Making of a World Power, 1492–1763*. London: Allen Lane.
- Kriedte, Peter, Hans Medick, and Jürgen Schlumbohm (1981). *Industrialization Before Industrialization. Rural Industry in the Genesis of Capitalism*. Cambridge: Cambridge University Press.
- Lafuente, Antonio (2000). Enlightenment in an Imperial Context: Local Science in the Late-Eighteenth-Century Hispanic World. *Osiris* 15:155–173.
- Lafuente, Antonio and Nuria Valverde (2005). Linnaean Botany and Spanish Imperial Biopolitics. In: *Colonial Botany: Science, Commerce, and Politics in the Early Modern World*. Ed. by Londa Schiebinger and Claudia Swan. Philadelphia: University of Pennsylvania Press, 134–147.
- Newitt, Malyn (2005). *A History of Portuguese Overseas Expansion, 1400–1668*. London: Routledge.

- Ogilvie, Sheilagh C. and Markus Cerman (1996). Proto-Industrialization. Economic Development and Social Change in Early Modern Europe. In: *European Proto-Industrialization*. Ed. by Sheilagh C. Ogilvie and Markus Cerman. Cambridge: Cambridge University Press, 227–239.
- Pardo-Tomás, José (2002). *Oviedo, Monardes, Hernández. El tesoro natural de América. Colonialismo y ciencia en el siglo XVI*. Madrid: Nivola.
- Patiniotis, Manolis and Kostas Gavroglu (2012). The Sciences in Europe: Transmitting Centers and the Appropriating Peripheries. In: *The Globalization of Knowledge in History*. Ed. by Jürgen Renn. Berlin: Edition Open Access, 321–343.
- Pinto, Paulo Jorge de Sousa (2013). Malaca, Manila e Batávia: os chineses ultramarinos no contexto dos impérios europeus na Ásia do Sueste (séculos XVI–XVII). In: *Mestiçagens e identidades intercontinentais nos espaços lusófonos*. Ed. by Manuel Lobato and Maria de Deus Manso. Braga: Núcleo de Investigação em Ciências Políticas e Relações Internacionais, 91–108.
- Raj, Kapil (2013). Beyond Postcolonialism... and Postpositivism. Circulation and the Global History of Science. *Isis* 104:337–347.
- Randeira, Shalini (1999). Geteilte Geschichte und verwobene Moderne. In: *Zukunftsentwürfe: Ideen für eine Kultur der Veränderung*. Ed. by Jörn Rüsen, Hanna Leitgeb, and Norbert Jegelka. Frankfurt am Main/New York: Campus Verlag, 87–96.
- Renn, Jürgen (2012). The Place of Local Knowledge in the Global Community. In: *The Globalization of Knowledge in History*. Ed. by Jürgen Renn. Berlin: Edition Open Access, 369–397.
- Sánchez Menchero, Mauricio (2012). *El corazón de los libros. Alzate y Bartolache: Lectores y escritores novohispanos (s. XVIII)*. Mexico: UNAM, Centro de Investigaciones Interdisciplinarias en Ciencias y Humanidades.
- Schlumbohm, Jürgen (1996). ‘Proto-Industrialization’ as a Research Strategy and a Historical Period – a Balance-Sheet. In: *European Proto-Industrialization*. Ed. by Sheilagh C. Ogilvie and Markus Cerman. Cambridge: Cambridge University Press, 12–22.
- Simões, Ana, Ana Carneiro, and Maria Paula Diogo (1999). Constructing Knowledge: Eighteenth-Century Portugal and the New Sciences. In: *The Sciences in the European Periphery during the Enlightenment*. Ed. by Kostas Gavroglu. Dordrecht et al.: Springer, 1–40.
- Soto Arango, Diana (1995). La Eseñanza ilustrada en las universidades de América colonial. Estudio historiográfico. In: *La Ilustración en América colonial. Bibliografía crítica*. Ed. by Diana Soto Arango, Miguel Puig-Samper, and Luis Carlos Arboleda. Madrid: CSIC, Doce Calles, Colciencias, 91–119.
- Subrahmanyam, Sanjay (2012). *The Portuguese Empire in Asia, 1500–1700: A Political and Economic History*. Oxford: Wiley-Blackwell.
- Temple, William (1814). On Ancient and Modern Learning. In: *The Works of Sir William Temple, Bart.* Vol. 3. London: Rivington et al., 444–486.
- Vries, Jan de (1994). The Industrial Revolution and the Industrious Revolution. *The Journal of Economic History* 54(2):249–270.
- (2008). *The Industrious Revolution: Consumer Behavior and the Household Economy, 1650 to the Present*. Cambridge: Cambridge University Press.
- Wendt, Helge (2011a). *Die missionarische Gesellschaft. Mikrostrukturen einer kolonialen Globalisierung*. Stuttgart: Franz Steiner Verlag.
- (2011b). Mission transnational, trans-kolonial, global. Perspektivverschiebungen in der Missionsgeschichtsschreibung. *Schweizer Zeitschrift für Religions- und Kirchengeschichte* 105:95–116.
- Withers, Charles W. J. (2007). *Placing the Enlightenment: Thinking Geographically about the Age of Reason*. Chicago: University of Chicago Press.
- Županov, Ines G. (2005). *Missionary Tropics: The Catholic Frontier in India (16th–17th Centuries)*. The University of Michigan Press.